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EMBEDDED COMPUTER RESOURCES AND THE DSARC PROCESS - A GUIDEBOOK--ETC(U)
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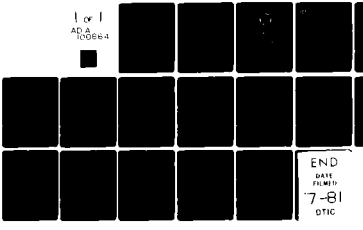

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DSARC, Defense System Acquisition Review Council, ASARC, Army System Acquisition Review Council, NSARC, Navy System Acquisition Review Council, AFSARC, Air Force Acquisition Review Council, embedded computer, embedded computer resources, computer resources, acquisition management, system management, software acquisition, acquisition policy, acquisition planning, defense systems, program reviews,

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The guidebook provides guidelines to access the adequacy of embedded computer resources planning and utilization. Separate sections address Defense System Acquisition Review Council (DSARC) milestones I, II, and III (Demonstration and Validation decision, Full-Scale Development decision, and Production and Deployment decision, respectively). Definitions of computer resource terms are given as is a matrix of available regulations and standards that pertain to various computer resource topics. 128 references are listed. The guidebook is a revision of the 1977 edition (AD A046395).

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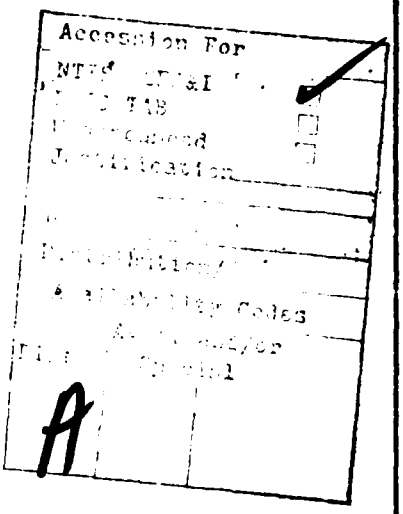

EMBEDDED COMPUTER RESOURCES AND THE DSARC PROCESS

– A GUIDEBOOK –

April 1981

OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON D C 20301

RESEARCH AND
ENGINEERING

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The first revision of "Embedded Computer Resources and the DSARC Process" reflects comments of those who used and reviewed the original 1977 edition. It contains an expanded references section and the definitions of specialized terms have been added.

Computer resources have clearly become a subsystem of major significance to most all defense systems. The annual investment by the DoD is measured in the billions of dollars. Since the greater portion of these dollars are in the operation and support phase of the life cycle, it is important to manage the upstream decisions to minimize their later impacts. Particular emphasis is given to standardization policies for high order programming languages and instruction set architectures which have been established from the DoD level.

Copies are being widely distributed throughout the DoD acquisition community to the Program-Manager level and to the Headquarters elements responsible for program reviews. Staff elements of the Office of the Secretary of Defense should use the guidebook in preparation for Defense Systems Acquisition Review Council milestone activity. It is our desire that the Military Departments adapt and tailor the guidebook to their special needs for regular Major Command or Service System Acquisition Review Council (SSARC) reviews. It should also be of value in preparation of Inspector General and Defense Audit Agency checklists.

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Deputy Director
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& Electronics)

TABLE OF CONTENTS

SECTION I

INTRODUCTION

The purpose of this guidebook is to provide guidelines to assess the adequacy of embedded computer resource planning and utilization. The level of Defense System Acquisition Review Council (DSARC) interest in embedded computer resources is related both to the percentage of development, acquisition, and support funds represented and to the criticality of system performance and support that these resources represent.

Sections II, III, and IV address issues on Milestone I, II, and III respectively and are based on the three major DSARC meetings. DSARC reviews are normally required for all defense systems designated by the Secretary of Defense as "major" usually involving over $100 million (FY80 dollars) in research, development, test and evaluation or over $500 million (FY80 dollars) in production. (See DoD Directive 5000.1 and DoD Instruction 5000.2 for further details.) In this guidebook, the term "defense system" implies either major or less-than-major systems which are not principally of an "ADPE" nature. Milestone I, II, and III reviews are held prior to entering the demonstration and validation phase, the full-scale engineering development phase, and the production and deployment phase, respectively. After the reviews, the Secretary of Defense decides if the system should proceed to the next phase. Sections I, II, and III emphasize embedded computers (i.e. those computers integral to weapon systems from a design, acquisition, operations, and dedicated support viewpoint) rather than general purpose computers that may be used to provide incidental support for some systems. Major computer resources issues will be determined by the system application; that is, high-unit-cost, low-production quantity systems may have quite different issues than low-unit-cost, high-production-quantity systems. Each of the three sections consists of a series of questions of concern to Office of the Secretary of Defense (OSD) personnel prior to Milestones I, II, and III. The OSD staff may ask similar questions at review meetings held prior to convening of the DSARC. DSARC principals should be thoroughly briefed by their staff on critical management issues identified by using these questions.

Section V is a series of definitions of computer resources terms. They are presented in an attempt to achieve common terminology throughout the embedded computer community.

Section VI contains a matrix that details available regulations and standards that pertain to various computer resource topics. References are listed by issuing group immediately following the matrix. Miscellaneous references, including management guidebooks that have been published by the Air Force Aeronautical Systems Division and Electronic Systems Division, are also listed in this section.

Section VII contains a form which can be used to provide feedback suggestions to improve this guidebook. Such information will be utilized when the guidebook is updated. If a guidebook update workshop is given prior to the next revision, information on the workshop will be sent to all those who have submitted Guidebook Feedback Forms. We sincerely urge you to complete the form and return it with your comments on this guide.

SECTION II

MILESTONE I (DEMONSTRATION AND VALIDATION DECISION)

The Milestone I decision point is reached when the exploration of alternative systems concepts phase has been completed, the Mission Element Need Statement (DoDD 5000.1) approved, and selected alternatives warrant system demonstration. The period prior to Milestone I (Concept Exploration) is particularly critical relative to embedded computer decisions. The establishment of data rights, choice of High Order Language, choice of Instruction Set Architecture, and overall embedded computer resource acquisition strategy must be largely decided prior to Milestone I.

Candidate acquisition strategies should also be developed prior to Milestone I. A basic decision as to the applicability of DoD Directive 5100.40 should have been made and, if applicable, steps taken to comply with Public Law 89-306 on coverage, exemption, or waiver.

General Issues

1. What are the embedded computer requirements and software items that have been identified at the outset?

2. What steps are being made to insure software management visibility?

3. With what other systems will the system have to interface? Will any interfaces change during system development? What knowledge of system implementation of the external system is required? Is this information available? How will both national and international interoperability and standardization be demonstrated?

4. Will more than one agency or contractor develop software for the system? If so, who will coordinate necessary arrangement and technical interchange among them, and when necessary arbitrate disputes among them? Will the groups participate in each other's critical design reviews? How will software integration be managed?

5. What is the overall software maintenance concept? What special tools and facilities are required to support this concept?

6. How will requirement specifications be developed?

7. Who will perform analysis for reliability and maintainability, and perform independent quality and reliability assessments (DoDD 4155.1)?

8. What design reviews are planned during the life cycle? What agency has overall responsibility for the scheduling and conduct of design reviews? Will reviews be conducted in accordance with MIL-STD-1521A, or another standard?

9. How will the system requirements and design be validated prior to implementation? How will the system design be evaluated for feasibility?

10. To what extent should metric measurements be used in new equipment (DoDD 4120.18)?

Program Manager's Staff

1. What percentage of development costs will be spent on computer-related expenses?

2. How many dedicated program personnel are skilled in computers and software? What percentage of the staff does this represent?

3. How many dedicated program personnel have had operational experience in the project application area?

4. What plans have been made to obtain computer personnel temporarily from Federal Contractor Research Centers, Service laboratories, and support activities? From private consulting firms?

5. Who in the Program Office (PO) has overall responsibility for software acquisition or for coordinating requirements with the acquisition agency? Who will develop the advanced acquisition plan for the Program Manager?

6. Does the Program Manager (PM) have an experienced system engineer agent responsible for overseeing software systems engineering?

7. How will the PM provide for computer resources support requirements? Is there a dedicated Software Support Agency? How will PM and agency roles be defined?

8. What type of tracking scheme will the PO use to assure meeting milestone dates? What procedures will be used to provide cost visibility to embedded computer resources? How will these cost be tracked?

9. How will software design maturity and supportability be quantitatively assessed?

10. What is the scope of the Independent Verification and Validation (IV&V) effort? To whom will the IV&V organization report? How will the funding be handled? If performed by a contractor, when will the contract be let?

Operational Requirements

1. When will computer resource requirements be validated? When and how will the computer resource requirements be allocated to software and hardware?

2. Are the system operational requirements well defined? Have they stabilized? Are they realistic? How can this be proven? Are the operational requirements testable?

3. What are the areas of greatest risk? How will risk analysis be performed?

4. Which operational requirements are likely to change during development of the system? During system deployment? Will the software accommodate these changes? Are the changes specified clearly? What is the planned method of interface management and control?

5. What are the critical computational and decision algorithms? What are the plans for validating these algorithms and the timing assumptions of these algorithms?

6. How will changes in operational requirements be managed and controlled? How will changes in software requirements be controlled?

7. What are the security and privacy requirements for the system? How will these requirements be met?

Life Cycle Management

1. Has the Logistics Support Analysis been planned for the embedded computer hardware and software?

2. Does the system life cycle support activity match the software and hardware life cycle requirements?

3. How will the software responsibility be transferred, from the developer to the support activity or user? What will be the process employed by the software support activity or the user to update or otherwise maintain the software?

4. Will Operations and Maintenance funds (or Producability Engineering and Planning funds) be requested to support contractor activities directed toward providing training, maintenance capabilities, and documentation?

5. Who will perform design reviews for quality and for reliability and maintainability?

6. How and when will maintenance provisions be specified?

7. Has the funding for the integrated support resources been identified?

8. How will initial support requirements for spares and spare parts be determined? Is software support documentation specifically addressed and funded?

9. What computer hardware will be unique? What computer hardware will require development? Why can't standard hardware be used? How will replacement parts be obtained? Is there a similar system in another Service that can be adopted?

10. How will the firmware support requirements be established during the firmware development phase of the program? What documentation for firmware is contract deliverable with the firmware?

11. How will you insure anticipated changes during the life cycle will not exceed computer memory, timing, and input/output capacity?

12. Will one of the High Order Languages in DoD Instruction 5000.31 be used for programming? If not, why not? Has a formal waiver been issued? What percentage of the software will ultimately be written in assembly language?

13. What configuration control techniques will be used for software? For hardware?

14. Will vendor-developed support software be used? Will the government receive copies of the software for later use?

15. Will any Data Processing Activities be required for life cycle support of the system or any of its subsystems?

Tradeoff Issues

1. What tradeoffs will be made between the embedded computer and other methods of meeting the system requirements (alternative system architectural approaches)?

2. What criteria will be used to determine whether or not more than one processor will be used in the system? How will the partitioning of system software among processors be determined? What network architecture and intercommunication protocal standards will be employed (e.g. MIL-STD-1553B)?

3. How will hardware/software/firmware tradeoffs be made?

4. How will the processor architecture be determined?

5. If the decision to use a microprocessor has been made, what criteria will be used to determine whether a fixed architecture or a bit-slice microprocessor will be used? Is the selected microprocessor MIL-qualified? If not, must it be to meet stated requirements? Will the microprocessor be logistically supportable over the system life cycle?

6. How will the processor memory capacity be determined?

7. How will timing requirements be determined?

8. How will safety margins and growth capacities for memory, processor time, and input/output capabilities be determined? How will these resources be partitioned?

9. Will off-line software support be required? If so, what host computer will be used? What is the availability of the host computer? What support software is available on the host computer?

10. How will tradeoffs between contractor versus government support be made?

11. How will the team that participated in the original concepts studies be maintained intact for tradeoff studies?

12. How are operations and support personnel involved in tradeoff decisions?

Use of Existing Hardware and Software

1. Will one of the DoD-approved Instruction Set Architectures be used? If not, why not?

2. What new technology (computer, sensor, and control) must be developed or utilized? What are the risks in such a development effort?

3. What special tasks must be performed in the demonstration and validation phase to perfect new technologies?

4. How much system design can be obtained "off-the-shelf" from previous systems?

5. Which existing operational application and software support packages will be utilized? Are the application programs operational on the proposed computer? If

not, what are the major hardware/software differences? To what extent have the contractor's personnel used these packages previously?

Acquisition Strategy

1. How will source selection for embedded computer hardware be made? Who will perform the evaluation of contractor proposals? What are embedded-computer-resources-oriented source selection criteria?

2. How will competition be maintained as far as practical during system acquisition?

3. What hardware and/or software will be Government Furnished Equipment (GFE)? What hardware and/or software will be Contractor Furnished Equipment (CFE)?

4. How were the percentages of GFE and CFE determined? If there is a mix of GFE and CFE, who is responsible for solving system integration problems?

5. Which devices have or will be developed by other Program Offices? How will the split responsibilities be handled?

6. What considerations have been or are being made for foreign procurement?

7. When and where will the final acceptance of the embedded computer resources be made? Who will determine whether the system is acceptable?

8. How will life cycle costs be developed and used in determining the best acquisition strategy?

9. Will commercial computer resources be acquired for the system? Is approval from Government Services Agency required for any of the computer hardware?

Possible Future Problem Areas

1. Has preliminary systems analysis been performed? What hardware and/or software problems areas were discovered? How will these problems be solved in the demonstration and validation phase?

2. What critical areas must be resolved during the demonstration and validation phase? How?

3. Do you envision other risky areas? What are your plans to resolve anticipated problems?

SECTION III

MILESTONE II (FULL-SCALE DEVELOPMENT DECISION)

Milestone II is reached when the demonstration and validation activity has been completed and a recommendation on the preferred systems for full-scale development can be made.

General Issues

1. What are the present problems and the plans for resolving them?

2. How do you know present life cycle costs and time estimates are sound?

3. What is the computer resource budget for full-scale engineering development? Of the total computer resources to be spent during this phase, what percentage will be used for design, for coding, and for testing of computer software? What have these percentages been for the contractor in the past?

4. Have the acquisition strategy decisions that were previously made been reviewed? (Refer to Milestone I Acquisition Strategy questions.) Are any acquisition strategy issues still unresolved? If so, when will they be resolved?

5. Have all Program Manager's Staff questions from Milestone I been be answered?

Operational Requirements

1. Have the system operational requirements changed since Milestone I? Are they now stabilized?

2. How were the requirements for computer resources, including software and its support documentation, validated?

3. How was risk analysis performed?

4. How will you insure that the planned computer resources will meet stated operational requirements?

5. How will future changes to computer hardware and software requirements be made? What agency will be responsible for making the changes?

Life Cycle Management

1. Which Milestone I Life Cycle Management questions are still unanswered? When will the answers be known?

2. Has a Computer Resources Management Plan been written? By whom? Has it been approved? How and when will the plan be updated?

3. What are the milestones of the Computer Resources Management Plan? What criteria will be used to measure their attainment?

4. What steps have been planned for the software "turnover" from the contractor to the government and from the acquisition command to the using command?

5. How will the computer resources be integrated into the total system?

6. How will the overall system quality be determined?

7. What is the involvement of the Software Support Activity during the software development?

8. How were personnel and training requirements for supporting computer resources determined?

9. How can you demonstrate sufficient memory and timing growth capacity have been incorporated in the system design?

10. What software is contract deliverable? Is all unique support software deliverable? If not, why not?

11. What software documentation is contract deliverable?

12. What integrated support resources are contract deliverable?

13. What role should contractor warranties have?

14. How have producibility and production readiness been considered? If they have not been, when will these disciplines be evaluated for adequacy?

Tradeoff Issues

1. How were tradeoff decisions made? (Refer to Milestone I Tradeoff Issues questions.)

2. Did the user team that wrote the original operational requirements assist in cost versus capabilities tradeoff? If not, how were these tradeoffs evaluated?

Project Control

1. What management procedures will be used to control software development, cost and schedule. Are maintenance and logistic costs and scheduling included?

2. What milestones in the Computer Resources Management Plan will be used to control hardware and software development?

3. Will there be any parallel software development efforts? If so, how will they be controlled? What management procedures will be used to insure adequate visibility into the progress of subcontractors?

4. Has the use of an independent contractor for assessment of software progress been considered?

5. How will interface control (both intersystem and intrasystem) be handled?

Development Contract

1. Will the acquisition take place in accordance with DoD Directive 4105.55 (Public Law 89-306; the Brook's Act)? Why or why not?

2. Which type of contract will be employed for the software development? Why?

3. How will the contractor be tasked for software and software support items?

4. What provisions have been made to supply the contracting office with adequate technical information to write a development contract?

5. What will be the software-related contractor incentives?

6. How will the contract prevent minimizing of hardware at the expense of software? What are the contract incentives relating to computer resources?

7. Is all software listed as Computer Program Configuration Items? Which software is not deliverable?

8. Is all support software listed as deliverable? Is any proprietary? If so, how will this be handled?

9. Is there a software Design-to-Cost goal? How will progress toward this goal be measured?

10. What software documentation is contract-deliverable? How was the amount of documentation needed determined?

Testing

1. When will the system and program designs be baselined?

2. How will software testing be performed? What levels of testing will be employed? Will an independent analysis and evaluation be accomplished?

3. How will you insure the test data is representative of the total range of data and operational conditions that the system might encounter?

4. Are the software module test plans and software module test procedures adequate?

5. How will testing be used to clearly identify deficiencies as software or hardware related? How will the determination of whether errors are caused by hardware or software be made? How will regression testing be performed?

6. Are "test beds" or "hot benches" required to adequately test software? Will they become government property after testing is complete? If not, does the government have equivalent integration and testing facilities available? What "test bed" documentation is listed as a contract deliverable item(s)?

7. How will software modules be interfaced with one another? How will these interfaces be tested? How will software be integrated and tested as part of the system?

8. What critical questions and areas of risk still need resolving by testing? What are the test plans and milestones for resolving these problems?

9. How will test-related documentation and media be maintained to allow repeatability of tests? How will support documentation be maintained to allow traceability?

10. What test and calibration software doucmentation and media are listed as contract deliverables?

11. How will verification and validation be performed? Who will perform it?

Software Quality, Reliability, and Maintainability

1. How will you determine that quality, reliability, and maintainability goals and subsequent test standards are cost effective and the minimum essential?

2. Is one of the High Order Languages in DoD Instruction 5000.31 being used for programming? If not, why not? What is the estimated percentage of the software that will be written in assembly language?

3. How will you assure the software architecture will be modular?

4. How will you assure "top-down" software development methodology and structured programming will be used?

5. What programming standards and conventions will be used? How will they be enforced?

6. When will the Data Item Index be prepared and how will it be updated? How will you insure the documentation will be adequate for life cycle maintenance?

7. Which automatic debugging tools will be used during program development? Were they developed during the program? Are they deliverable?

8. How will error data be defined, collected, analyzed, and reported?

9. How will the software be integrated with the hardware during full-scale engineering development?

10. How will software be documented as it proceeds from concept to design to the final operational system?

11. How will the software be supported in the field? What hardware and software will be needed for the support base? How will it be procured?

12. Will Automatic Test Pattern Generators be used for support? If so, are they proprietary? How will they be maintained? What support documentation is contract deliverable? How will it be validated?

Miscellaneous Issues

1. What has the contractor done of a similar nature in the past? What were his successes and failures? What is he doing to eliminate past problem areas?

2. What method was used for estimating software life cycle costs? When was the original estimate made? How often has the estimate been revised? What have been the accuracy of previous estimates?

3. What problems must be solved prior to the Milestone III decision point that have not already been discussed? What is your plan for solving them?

4. Must data or programs in the system be secure? If so, at what level? What security issues must be resolved?

5. What is the government's mechanism to make an independent assessment of the software?

SECTION IV

MILESTONE III (PRODUCTION AND DEPLOYMENT DECISION)

The Milestone III decision point is reached when a production recommendation for the system can be made.

General Issues

1. Are the original operational requirements still valid? How can this be proven?

2. What is the status of producibility and production readiness?

Present Status

1. What are the results of the latest series of operational tests (on the entire weapon system)? Where are the current tests in relationship to the overall test plan?

2. What impact will the need for subsystem changes discovered during testing and evaluation of the overall weapon system have on embedded computer hardware and software and on spares and spare parts quantitative determinations?

3. Are any software modules incomplete? Which modules and associated hardware are involved? What is the extent of incompleteness and the schedule for completion?

4. What is the profile of the last three months of Discrepancy forms and Software Change Requests? How many discrepancies are still to be corrected? How is the error data collected and analyzed?

5. How much of the recent software change activity has been due to program errors and how much has been due to change in requirements? Were changes in requirements due to increased or decreased requirement? Who has the authority to change software requirements?

6. How has delivered code been verified to conform to original software design? Who prepared test data for the validation? How has delivered code been shown to satisfy original operational requirements? How was the support documentation validated?

7. How was hardware/software integration and validation performed?

Life Cycle Management

1. Are any Life Cycle Management questions from Milestone II still unanswered? Why?

2. What changes have been made to the Computer Resources Management Plan since Milestone II? Is the development schedule in accordance with the plan? What impact will slippages have on the entire system during production and deployment?

3. When will the software "turnover" from the contractor to the government take place? What steps must take place before the turnover? Is the procuring command prepared to turnover the software to the using command and the Software Support Activity?

4. Who will provide software support during deployment of the system? What equipment, facilities, personnel, software, etc. will be required in the support base? How will future modifications to baseline software be handled?

5. What will be the impact of anticipated software improvements? What are the anticipated improvements and which areas of the system will be involved?

6. What is the general logic flow for the system? How would government personnel go from the general flow chart to the source coding? Is a Data Item Index a deliverable item?

7. How is the software compatible with operation/logistics concepts?

Production Issues

1. How was software maturity (versus design maturity) measured during development?

2. What are the embedded computer related costs and schedule risks? How were they determined?

3. How can the completion of software development be shown quantitativeiy?

Miscellaneous Issues

1. How will changes to the computer hardware and software be made after deployment? How will these changes be funded? How will system configuration be controlled?

2. Under what conditions will a formal Operational Test and Evaluation be required for major computer hardware and/or software changes made after deployment of the weapon system? How will reliability of the changed system be demonstrated? How will the testing be funded?

3. In the event that quality, reliability, and maintainability are inadequate, how will they be improved?

4. Has the original acquisition strategy been reviewed and found to be adequate? What alternatives were considered?

5. Are there any "lessons learned" that should be passed on? What process will be used?

SECTION V
EMBEDDED COMPUTER RESOURCES DEFINITIONS

COMMERCIALLY AVAILABLE. Offered for sale to the general public and/or industry at established catalog or market prices. (As compared to Specially Designed.)

COMPUTER RESOURCES. The totality of:

a. Computer Data. Basic elements of information used by computer hardware in responding to a computer program.

b. Computer Hardware. Devices capable of accepting and storing computer data, executing a systematic sequence of operations on computer data, or producing control outputs. Such devices can perform substantial interpretation, computation, communication, control, and other logical functions.

c. Computer Program. A series of instructions or statements in a form acceptable to an electronic computer designed to cause the computer to execute an operation or series of operations. Computer programs include software such as operating systems, assemblers, compilers, interpreters, data management system, utility programs, and maintenance/diagnostic programs. They also include application programs such as payroll, inventory control, operational flights, strategic, tactical, automatic test, crew simulator, and engineering analysis programs. Computer programs may be either machine dependent or machine independent, and may be general purpose in nature or be designed to satisfy the requirements of a specialized process of a particular user.

d. Computer Resource Documentation. Printed or machine readable description of computer programs, computer hardware, or other computer resource assets necessary to support design, development, test, and life cycle maintenance.

e. Computer Personnel. All Government personnel, both civilian and military, who are identified with computer resource functions.

f. Computer Supplies. Items designed specifically for use with computer hardware, such as magnetic or paper tape, removable magnetic disk packs, punch cards, printer paper, and ribbons.

g. Computer Contractual Services. All services in support of a computer requirement and obtained on a contractual basis, including but not limited to: machine time, operations, maintenance, and engineering modifications; training; and professional services such as programming, systems analysis, systems design, systems engineering, and consulting.

h. Computer Software. A collection of associated computer programs and computer data required to enable the computer equipment to perform computational or control functions. NOTE: It is the abstract contents of tape, discs, card decks, and firmware.

(1) Support Software. Any software designed to support the development maintenance and modification of other software.

(2) Utility Program. A developmental tool necessary for the generation of the operational and support programs.

(3) Test Software. Software that is utilized in the testing of design and implementation of hardware and other software. NOTE: Testing is conducted to ensure that hardware and/or software adhere to design specifications, functional specifications, and performance specifications.

(4) Operational Software. Programs required to operate the system. These programs are loaded and run in the computer equipment during system operation and can include the following functions: executive/supervisor, functional/application, and input/output.

CONFIGURATION ITEM (CI). An aggregation of hardware/computer software, or any of its discrete portions, which satisfies an end-use function and is designated by the Government for configuration management. NOTE: In reference to computer software, the term Computer Program Configuration Item (CPCI) is used interchangeably.

COMPUTER PROGRAM CONFIGURATION ITEM (CPCI). See Configuration Item.

DEFENSE SYSTEM. A Defense System is a major system as designed by the Secretary of Defense or as managed under the provisions of DoD Directive 5000.1 (Major System Acquisition) and DoD Instruction 5000.2 (Major System Acquisition Procedures) or a less-than-major system managed by the components under similar review processes. Defense systems are associated with the conduct of the National Security Mission of the DoD as contrasted with the administration of the Department and may include dedicated support functions such as automatic test, training simulators, automated materials handling, etc.

DIRECT SUPPORT. Includes those functions such as specialized training, testing, or software support which are dedicated to the operation and maintenance of a system throughout its life cycle. Excluded are ADPE functions such as management information systems, configuration management, or logistics systems.

EMBEDDED COMPUTER. A computer incorporated as an integral part of, dedicated to, or required for direct support of, or for the upgrading or modification of, major or less-than-major systems.

FIRMWARE. Any level of computer program and/or computer data that cannot be readily modified under computer program control; that is, read only. The definition also applies to read only digital data that may be used by electronic devices other than digital computers.

HARDWARE INTENSIVE. Those computer applications in which the function is fixed and hence, the computer program is not expected to be changed (after development and test) for the lifetime of the physical component in which it is embedded.

Some of the factors which may be considered in determining whether an application program is likely to change are: the computer program size; the quantities associated with application system in which a computer or processor is embedded; the practice of making changes only to newly-produced units rather than retrofit to fielded units; the ratio of expected software life cycle cost to expected system life cycle cost; and the implementation of programs in read-only memory.

HIGH ORDER LANGUAGE (HOL). An HOL is a language used to communicate computational or procedural processes to a computer. An HOL provides compression of computer instructions such that one HOL statement or expression may cause many machine language instructions to be executed, and provides declarative and descriptive information that is not readily derivable from the corresponding sequence of machine instructions. An HOL is generally machine-independent although its implementations may not be.

INSTRUCTION SET ARCHITECTURE (ISA). The attributes of a digital computer or processor as might be seen by a machine (assembly) language programmer, i.e., the conceptual structure and functional behavior as distinct from the organization of the data flow and controls, logic design, and physical implementation.

This definition includes the processor and input/output instruction sets, their formats, operation codes, and addressing modes; the memory management and partitioning if accessible to the machine language programmer; the speed of accessible clocks; the interrupt structure; and the manner of use and format of all registers and memory locations that may be directly manipulated or tested by a machine language program.

This definition excludes the time or speed of any operation, the internal computer partitioning, the electrical and physical organization, the circuits and components of the computer, the manufacturing technology, the memory organization, the memory cycle time, and the memory bus widths.

INTEGRAL. Dedicated and essential to the specific functional task for which the higher order system was designed.

LANGUAGE CONTROL AGENT. The organization responsible for ensuring stability and configuration of the specified DoD-approved High Order Language. The Language Control Agent controls changes to the language standard and ensures changes receive appropriate review.

LESS-THAN-MAJOR SYSTEM. Any system not designated as a major system by the Secretary of Defense but managed in accordance with the principles of DoDD 5000.1 and DoDI 5000.2.

MACHINE ORIENTED LANGUAGE (MOL). MOLs including Assembly Languages are machine-dependent languages used to communicate programs on a one-for-one basis with machine language instruction.

MAJOR SYSTEM. A system so designated by the Secretary of Defense and managed under DoD Directive 5000.1 and DoD Instruction 5000.2.

SOFTWARE ENGINEERING. The branch of science and technology which deals with the design, development, documentation, implementation, test, evaluation, verification, operational use, and maintenance of computer software throughout its life cycle.

SPECIALLY DESIGNED. Government specified and not commercially available. Excludes specially configured. (As compared to Commercially Available.)

SOFTWARE MAINTENANCE. Error correction associated with incorrect implementation of software as defined in the specifications or those due to programming errors. Software maintenance does not include modifications in support of changing needs or requirements.

SOFTWARE MODIFICATION. Software changes made to accommodate changing needs or requirements.

VALIDATION. The evaluation, integration, and test activities carried out at the system level to ensure that the finally-developed system satisfies the mission requirements set down as performance and design criteria in the system specification.

VERIFICATION (OF COMPUTER PROGRAMS). The interactive process of determining whether the product of each step of the CI development process fulfills all of the requirements levied by the previous step. Examples of this process are:

a. System engineering analytical activities carried out to ensure that the CI Development Specifications reflect the performance requirements allocated from the System Specification.

b. Design evaluation activities carrier out to ensure that the CI design continues to meet the requirements of the Development Specification as the design proceeds to greater levels of detail.

c. Informal testing of the CI and its components.

d. Formal qualification testing of the CI to verify that the CI fulfills the requirements of the Development Specification.

Definitions for other terms can be found in EIA Configuration Management Bulletin No. 4-1A and the DACS Glossary (refer to References section).

EMBEDDED COMPUTER REGULATIONS & STANDARDS

	ACQUISITION POLICY AND TEHMS/DEFINITIONS	AUDITS REVIEWS	CODING	COMPUTER SECURITY	CONFIGURATION MANAGEMENT	DELIVERY	DESIGN	DOCUMENTATION	HIGH ORDER LANGUAGES	INSTRUCTION SET ARCHITECTURES	MAINTENANCE & SUPPORT	QUALITY ASSURANCE	RELIABILITY	SOFTWARE ACQUISITION MANAGEMENT	TESTING
DOD	4120.21 5000.1 5000.2 5000.29 5000.37			5200.28	5010.19	5000.3 5010.2 5010.12	5000.28	7935.1 S	5000.31	5000.5X	5000.39	4155.1	5000.40	5000.1 5000.29	5000.3
ARMY	DARCOM R 70-16 310-25	70-37	18-12	380-380	70-37	70-1 702-3 1000-1		70-27 310-3	Army Policy Letter	Army Policy Letter	700-127 750-1	70-10 702-2 702-4	702-3	DARCOM R 70-16	70-1 70-10 70-29 70-38 71-3 1000-1
NAVY	5000.1A 5200.32 TAD STAND A		5233.1		5000.1A		5233.1 TAD STANDS 3, B & D	8560.1 5233.1 8506 TAD STAND 2	TAD STAND C			TAD STAND 9		5000.1A 5231.1	TAD STAND 9
AIR FORCE	800-2 800-12 800-14 800-28			300-8	57-4 65-3	800-14		800-14	800-10	800-14 AFSC Sup 1	800-14 800-19 800-21	122-9 122-10		800-14	80-14
STANDARDS	1098 1438 482A 7218 1679 FIPS 11-1	1521A 483	1679 483	FIPS 41	480A 481A 482A 483 785B 1679 52779A		765A 1472B 1553B 1679	1000 483 490	1589B 1753 1815 CMS 2Y CMS 2M SPL 1 IEEE 416	1750A 1862 ELEX P 351 PD PMS 408 1 A85232	470 483 7218	1098 1679 O9858A 52779A	756A 757 785B	499A 1679	1679

EMBEDDED COMPUTER RESOURCES REFERENCES

A. DoD Directives, Instructions and Standards

1. DoDD 4105.55, "Selection and Acquisition of Automatic Data Processing Resources," dated 19 May 1972, incl. Changes 1, 2, and 3

2. DoDD 4120.3, "Defense Standardization and Specification Program," dated 10 February 1979

3. DoDD 4120.18, "Metric System of Measurement," dated 28 January 1980

4. DoDI 4120.20, "Development and Use of Non-Government Specifications and Standards," dated 28 December 1976

5. DoDD 4120.21, "Specifications and Standards Application," dated 9 April 1977

6. DoDD 4155.1, "Quality Program," dated 10 August 1978, incl. Change 1

7. DoDD 5000.1, "Major System Acquisitions," dated 19 March 1980

8. DoDI 5000.2, "Major System Acquisition Procedures," dated 19 March 1980

9. DoDD 5000.3, "Test and Evaluation," dated 26 December 1979

10. DoDD 5000.28, "Design to Cost," dated 23 May 1975

11. DoDD 5000.29, "Management of Computer Resources in Major Defense Systems," dated 26 April 1976, incl. Change 1 (being revised)

12. DoDI 5000.31, "Interim List of DoD Approved High Order Programming Languages (HOLs)," dated 24 November 1976 (Revision in final coordination)

13. DoDD 5000.37, "Acquisition and Distribution of Commercial Products (ADCP)," dated 29 September 1978

14 DoDD 5000.39, "Acquisition and Management of Integrated Logistic Support for Systems and Equipment," dated 17 January 1980

15. DoDD 5000.40, "Reliability and Maintainability," dated 8 July 1980

16. DoDI 5000.5x, "Instruction Set Architecture (ISA) Standardization Policy for Embedded Computers." (In final coordination)

17. DoDD 5010.12, "Management of Technical Data," dated 5 December 1968, incl. Change 1

18. DoDD 5010.19, "Configuration Management," dated 1 May 1979

19. DoDD 5100.40, "Responsibility for the Administration of the DoD Automatic Data Processing Program," dated 19 August 1975, incl. Change 1

20. DoDD 5200.28, "Security Requirements for Automatic Data Processing (ADP) Systems," dated 18 December 1972, incl. Change 2

21. DoDD 7920.1, "Life Cycle Management of Automated Information Systems (AIS)," dated 17 October 1978

22. DoDI 7920.2, "Major Automated Information Systems Approval Process," dated 20 October 1978

B. Army Documents

1. Assistant Secretary of the Army Policy Letter, subject: "Standardization of Embedded Computer Resources," dated 1 July 1980

2. AR 18-1, "Army Automation Management," dated 15 August 1980

3. AR 18-12, "Catalog of Standard Data Elements and Codes," dated 29 March 1974

4. AR 70-1, "Army Research, Development, and Acquisition," dated 1 May 1975

5. AR 70-10, "Test and Evaluation during Development and Acquisition of Materiel," dated 29 August 1975

6. DARCOM Reg. 70-16, "Management of Computer Resources in Battlefield Automated Systems," dated 16 July 1979

7. AR 70-27, "Outline Development Plan/Development Plan/Army Program Memorandum/Defense Program Memorandum/Decision Coordinating Paper," dated 17 March 1975

8. AR 70-29, "Production Testing of DSA-managed Items," dated 27 May 1969

9. AR 70-37, "Configuration Management," dated 1 July 1974

10. AR 70-38, "Research, Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions," dated 5 May 1969

11. AR 71-3, "User Testing," dated 8 March 1977

12. AR 310-3, "Preparation, Coordination, and Approval of Department of Army Publications," dated 20 December 1968

13. AR 310-25, "Dictionary of US Army Terms," dated 15 September 1975

14. AR 380-380, "Automated Systems Security," dated 14 October 1977

15. AR 700-127, "Integrated Logistics Support," dated 11 April 1975

16. AR 702-2, "Uniform Quality Control System," dated 3 December 1970

17. AR 702-3, "Army Materiel Reliability, Availability, and Maintainability," dated 15 November 1976

18. AR 702-4, "Procurement Quality Assurance," dated 3 August 1976

19. AR 750-1, "Army Materiel Maintenance Concepts and Policies," dated 1 April 1978

20. AR 1000-1, "Basic Policies for System Acquisition," dated 1 May 1981

21. Technical Bulletin 18-115, "Army Information Processing Standards (AIPS)," dated 3 July 1980

C. Navy Documents

1. SECNAVINST 3560.1, "Tactical Digital Systems Documentation Standards," dated 8 August 1974

2. SECNAVINST 5000.1A, "System Acquisition in the Department of the Navy," dated 17 November 1978

3. SECNAVINST 5200.32, "Management of Embedded Computer Resources in the Department of the Navy Systems," dated 11 June 1979

4. SECNAVINST 5231.1, "Management of Automated Data Systems Development," dated 25 February 1972

5. SECNAVINST 5233.1A, C-1, "Department of the Navy Automated Data System Documentation Standards," dated 30 August 1974

6. WS-8506, "Requirements for Digital Computer Program Documentation," dated 1 November 1971

7. TADSTAND 2, "Standard Specification for Tactical Digital Computer Program Documentation," dated 1 November 1974

8. TADSTAND 3, "Standard Requirements for Inter-digital Processor Interface Documentation," dated 5 November 1974

9. TADSTAND 9, "Software Quality Testing Criteria Standard for Tactical Digital Systems," dated 18 August 1978

10. TADSTAND A, "Standard definitions for Embedded Computer Resources in Tactical Digital Systems," dated 2 July 1980

11. TADSTAND B, "Standard Embedded Computers, Computer Peripherals, and Input/Output Interfaces," dated 2 July 1980

12. TADSTAND C, "Computer Programming Language Standardization Policy for Tactical Digital Systems," dated 2 July 1980

13. TADSTAND D, "Reserve Capacity Requirements for Tactical Digital Systems," dated 2 July 1980

D. Air Force Documents

1. AFR 57-4, "Modification Program Approval," dated 15 December 1977, incl. Change 1; AFSC Sup. 1, dated 1 April 1974

2. AFR 65-3, "Configuration Management," revised 1 September 1974; AFSC Sup. 1, dated 25 July 1975

3. AFR 80-14, "Test and Evaluation," dated 19 July 1976; AFSC Sup. 1, dated 3 January 1977

4. AFR 122-9, "The Nuclear Safety Cross-Check Analysis and Certification Program for Weapon Systems Software," dated 22 October 1976; AFSC Sup. 1, dated 22 March 1977

5. AFR 122-10, "Nuclear Weapon System Safety Design and Evaluation Criteria," dated 27 November 1978

6. AFR 300-8, "Security Requirements for Automatic Data Processing Systems (ADPS)," dated 3 June 1974

7. AFR 300-10, "Computer Programming Languages," dated 15 December 1976

8. AFR 800-2, "Acquisition Program Management," dated 14 November 1977

9. AFLCR 800-12, "Acquisition of Support Equipment," dated 20 May 1974

10. AFR 800-14, V.I, "Management of Computer Resources in Systems," dated 12 September 1975; AFLC Sup. 1, dated 15 October 1976; AFSC Sup. 1, dated 8 August 1977; ESD Sup. 1, dated 8 August 1977

11. AFR 800-14, V.II, "Acquisition and Support Procedures for Computer Resources in Systems," dated 26 September 1975; AFLC Sup. 1, dated 18 October 1976; ESD Sup. 1, dated 25 November 1975

12. AFR 800-19, "System or Equipment Turnover," dated 27 May 1975

13. AFLCR 800-21, "Management and Support Procedures for Computer Resources Used in Defense Systems," dated 4 January 1980

14. AFR 800-28, "Air Force Policy on Avionics Acquisition and Support," dated 11 September 1978

E. Standardization Documents

1. DoD-STD-100C, "Engineering Drawing Practices," revised 22 December 1978; Notice 1, dated 30 April 1980

2. MIL-STD-109B, "Quality Assurance Terms and Definitions," dated 4 April 1969

3. MIL-STD-143B, "Order of Precedence for the Selection of Standards and Specifications," dated 12 November 1969

4. MIL-STD-470, "Maintainability Program Requirements (for Systems and Equipment)," dated 21 March 1966

5. DOD-STD-480A, "Configuration Control - Engineering Changes, Deviations and Waivers," dated 12 April 1978

6. MIL-STD-481A, "Configuration Control - Engineering Changes, Deviations and Waivers (Short Form)," dated 18 October 1972

7. MIL-STD-482A, "Configuration Status Accounting Data Elements and Related Features," dated 1 April 1974

8. MIL-STD-483 (USAF), "Configuration Management Practices for Systems, Equipment, Munitions and Computer Software," revised 1 June 1971; Notice 2, dated 21 March 1979

9. MIL-STD-490, "Specification Practices," revised 18 May 1972

10. MIL-STD-721B, "Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety," revised 10 March 1970

11. MIL-STD-756A, "Reliability Prediction," dated 15 May 1963

12. MIL-STD-757, "Reliability Evaluation from Demonstration Data," dated 19 June 1964

13. MIL-STD-785B, "Reliability Program for Systems and Equipment Development and Production," revised 15 September 1980

14. MIL-STD-1472B, "Human Engineering Design Criteria for Military Systems, Equipments and Facilities," revised 10 May 1976; Notice 2, dated 10 May 1978

15. MIL-STD-1521A (USAF), "Technical Reviews and Audits for Systems, Equipments and Computer Programs," dated 1 June 1976; Notice 1, dated 27 September 1978

16. MIL-STD-1553B, "Aircraft Internal Time Division Command/Response Multiplex Data Bus," dated 21 September 1978; Notice 1, dated 12 February 1980

17. MIL-STD-1589B(USAF), "JOVIAL (J73)," dated 6 June 1980

18. MIL-STD-1679 (NAVY), "Weapon System Software Development," dated 1 December 1978

19. MIL-STD-1750A(USAF), "Sixteen-Bit Computer Instruction Set Architecture," dated 2 July 1980

20. MIL-STD-1753, "FORTRAN, DoD Supplement to American National Standard X3.9-1978," dated 9 November 1978

21. MIL-STD-1815, "Ada Programming Language," dated 10 December 1980

22. MIL-STD-1862, "Instruction Set Architecture for the Military Computer Family," dated 28 May 1980

23. DoD Standard 7935.1-S, "Automated Data Systems Documentation Standards," dated 13 September 1977

24. MIL-Q-9858A, "Quality Program Requirements," dated 16 December 1963

25. MIL-S-52779A (AD), "Software Quality Assurance Program Requirements," dated 1 August 1979

26. ANSI/IEEE Std 416-78, "Standard ATLAS Test Language"

27. FIPS Pub 11-1, "Dictionary for Information Processing," dated 30 September 1977

28. FIPS Pub 24, "Flowchart Symbols and their Usage in Information Processing," dated 30 June 1973

29. FIPS Pub 30, "Software Summary for Describing Computer Programs and Automated Data Systems," dated 30 June 1974

30. FIPS Pub 41, "Computer Security Guidelines for Implementing the Privacy Act of 1974," dated 30 May 1975

31. "CMS-24 Programmer's Reference Manuals," M-5049 and M-5044 FCDSSA, San Diego, CA, December 1978

32. "CMS-2M Computer Performance Specification," NAVELEX 0967LP-598-2210, October 1978

33. "SPL/1 Language Reference Manual," 5490-163; EF:vjs, NRL, Washington, DC

F. Guidebooks and Miscellaneous References

1. ASD-TR-76-11, "Management Guide to Avionics Software Acquisition: Vol. I, An Overview of Software Development and Management, (AD A030591); Vol. II, Software Acquisition Process (AD A030592); Vol. III, Summary of Software Related Standards and Regulations (AD A030593); Vol. IV, Technical Aspects Relative to Software Acquisition (AD A030594)," June 1976

2. ASD-TR-78-6, (AD A058428), "Engineering Guide to Avionics Software Acquisition: Requirements, Specifications, and Standards"

3. ASD-TR-78-7, (AD A058429), "Engineering Guide to Avionics Software Acquisition: Reviews and Audits"

4. ASD-TR-78-8, (AD A059068), "Airborne Systems Software Acquisition Engineering Guidebook for Quality Assurance," November 1977

5. ESD-TR-75-85, (AD A016488), "An Air Force Guide to Monitoring and Reporting Software Development Status," September 1975

6. ESD-TR-75-91, (AD A016401), "Software Acquisition Management Guidebook: Requirements, Specifications, and Standards," October 1975

7. ESD-TR-75-365, (AD A020444), "An Air Force Guide to Contracting for Software Acquisition," January 1976

8. ESD-TR-76-159, (AD A027051), "An Air Force Guide to Software Documentation Requirements," June 1976

9. ESD-TR-77-16, (AD A035924), "Software Acquisition Management Guidebook: Statement of Work Preparation," January 1977

10. ESD-TR-77-22, (AD A037115), "Software Acquisition Management Guidebook: Life Cycle Events," February 1977

11. ESD-TR-77-130, (AD A038234), "Software Acquisition Management Guidebook: Software Development and Maintenance Facilities," April 1977

12. ESD-TR-77-263, (AD A048577), "Software Acquisition Management Guidebook: Validation and Certification," August 1977

13. ESD-TR-77-254, (AD A047308), "An Air Force Guide to Computer Program Configuration Management," August 1977

14. ESD-TR-77-255, (AD A047318), "Software Acquisition Management Guidebook: Software Quality Assurance," August 1977

15. ESD-TR-77-263, (AD A048577), "Software Acquisition Management Guidebook: Verification," August 1977

16. ESD-TR-77-326, (AD A053039), "Software Acquisition Management Guidebook: Validation and Certification," August 1977

17. ESD-TR-77-327, (AD A053040), "Software Acquisition Management Guidebook: Software Maintenance," October 1977

18. ESD-TR-78-117, (AD A052567), "Software Acquisition Management Guidebook: Reviews and Audits," November 1977

19. ESD-TR-78-139, (AD A055573), "An Air Force Guide to the Computer Program Development Specification," March 1978

20. ESD-TR-78-140, (AD A055574), "Software Acquisition Management Guidebook: Software Cost Estimation and Measurement," March 1978

21. ESD-TR-78-141, (AD A055575), "Software Acquisition Management Guidebook: Series Overview," March 1978

22. "Tactical Embedded Computer Software Audit Manual," dated 2 May 1980 (available from HQ, NAVMAT-08Y)

23. "EIA Configuration Management Bulletin No. 4-1A, Configuration Management for Digital Computer Programs (Definitions)," (available from Electronic Industries Association, Engineering Department; 2001 Eye Street, N.W., Washington, DC 20006)

24. "The DACS Glossay, A Bibliography of Software Engineering Terms," October 1979 (available from Data and Analysis Center for Software, RADC/ISISI, Griffiss Air Force Base, NY 13441)

25. Public Law 89-306, 89th Congress, H.R. 4845, dated 30 October 1965, "Brook's Bill"

Comments on Embedded Computer Resources and the DSARC Process -
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___ General

___ Specific (Page _____, Paragraph or question _____)

COMMENT/SUGGESTED CHANGE (Continue on extra sheets if necessary.):

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